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Report No. CG-D-76-78

VOLUME IV OF IV

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16. Abstract

This report is the product of a 2-year study of mobile offshore drilling unit (MODU) operations. The study was performed for the U.S. Coast Guard to provide a basis for establishing marine-related qualifications requirements for MODU personnel.

Functional Job Analysis (FJA) was used to prepare detailed, standardized descriptions of the tasks required under routine and emergency conditions, taking into account MODU design and equipment, availability of personnel, and environmental variables. The study addressed all five design types of MODU: drill ships, floating drill barges, submersibles, semisubmersibles, and self-elevating units. Four modes of operation were analyzed: the underway mode (moves to/from the drilling site), the transition from underway status to drilling status, the drilling mode, and the emergency mode (including four specific emergency conditions). The functional area of onboard personnel supervision and training is treated separately. Industry practices in the selection and training of personnel were reviewed for comparison with the experience and training needs indicated by the analysis.

The report is presented in four volumes, the first of which provides background descriptions of MODU characteristics and operations, a summary of the results, and the recommendations made by the study team. Volumes II and III contain the task data. Volume IV is an appendix of supporting materials.

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ORGANIZATION OF APPENDIX

This volume is an appendix to the three volumes of the report entitled Functional Job Analysis of Mobile Offshore Drilling Unit Operations. This appendix includes the following sections:

Section A: A list of references of information cited in Volumes I, II, and III

Section B: An annotated bibliography of books and periodicals used to obtain background information on offshore drilling operations and current data on the five mobile offshore drilling unit (MODU) design types covered in this report

Section C: A list of courses and schools currently available for offshore drilling personnel

Section D: A detailed description of Functional Job Analysis (FJA), the task analysis method used in this study

Section E: Copies of the FJA scale definitions used to complete the ratings on the task analysis sheets.

SECTION A: REFERENCES

VOLUME I

Fine, S., Functional Job Analysis: An Approach to a Technology for Manpower Planning, Washington, D.C.: W.E. Upjohn Institute for Employment Research, February 1973.

Fine, S., A. Holt, and M. Hutchinson, Functional Job Analysis: How to Standardize Task Statements, Methods for Manpower Analysis, No. 9, Washington, D.C.: W.E. Upjohn Institute for Employment Research, November 1973.

Geological Survey, Conservation Division, Outer Continental Shelf Standard No. 1, (GSS-OCS-1), First Edition: "Safety Requirements for Drilling in a Hydrogen Sulfide Environment," Washington, D.C.: The U.S. Department of the Interior, February 1976.

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Offshore Rig Data Services, "The Offshore Rig Location Report, September 1977," Houston, Texas: The Sheffer Company.

Petroleum Extension Service, Lessons in Rotary Drilling, Unit 1, Lesson 1: "The Rotary Rig and its Components," Austin, Texas: The University of Texas in cooperation with the International Association of Drilling Contractors, Houston, Texas, 1976.

Petroleum Extension Service, Lessons in Rotary Drilling, Unit 5, Lesson 2: "Spread Mooring Systems," Austin, Texas: The University of Texas in cooperation with the International Association of Drilling Contractors, Houston, Texas, 1976.

Wilson, Lejeune, Presentation at the 9th Annual Offshore Technology Conference, Houston, Texas, May 2-5, 1977. Proceedings forthcoming.

VOLUME II

Harris, L.M., An Introduction to Deepwater Floating Drilling Operations, Tulsa, Oklahoma: Petroleum Publishing Company, 1972.

Ocean Industry, "1976-77 Directory of Marine Drilling Rigs," Houston, Texas: Gulf Publishing Company, September 1976.

Petroleum Extension Service, Technical Papers from the School of Offshore Operations, Volume I (First Week), Austin, Texas: The University of Texas, 1976-1977.

VOLUME III

Snider, W.D., G.J. Buffleben, J.R. Harrald, K.F. Bishop and J.C. Card, Management of Mid-Atlantic Offshore Development Risks, Paper presented at the Symposium on Marine Resource Development in the Middle Atlantic States, sponsored jointly by the Chesapeake and Hampton Roads Sections of the Society of Naval Architects and Marine Engineers, October 29-30, 1976.

VOLUME IV

Fine, S. and F. Bernotavicz, Task Analysis: How to Use the National Task Bank, Methods for Manpower Analysis, No. 7., Washington, D.C.: W.E. Upjohn Institute for Employment Research, November 1973.

Fine, S. and W. Wiley, An Introduction to Functional Job Analysis: A Scaling of Selected Tasks From the Social Welfare Field, Methods for Manpower Analysis, No. 4., Washington, D.C.: W.E. Upjohn Institute for Employment Research, September 1971.

SECTION B: ANNOTATED BIBLIOGRAPHY OF BOOKS AND PERIODICALS

ANNOTATED BIBLIOGRAPHY OF BOOKS

American Bureau of Shipping, Rules for Building and Classifying Offshore Mobile Drilling Units, 1968.

> Rules for (1) construction and classification of steel vessels, (2) construction and classification of machinery, (3) inspection and testing of materials, fire pumps and fire extinguishing systems, and (5) surveys. In addition, tables of scantlings, tables of equipment, and load line markings are included.

American Petroleum Institute, Division of Production, Primer of Oil and Gas Production, 2nd ed., Dallas, Texas, 1962.

> This is part of a vocational training series introducing a student to the basic elements of drilling. Chapters include discussion of the origin and accumulation of gas; the well; well treatment; the well head; artificial lift; well testing; separation and treatment of oil and gas; the storage system; gaging and switching; special problems; fluid injection; production personnel; tools; pipes, valves and fittings; reports and records; state oil and gas regulations; percentage depletion. A glossary of terms is provided.

American Petroleum Institute, Petroleum/Energy Business News Index, Central Abstracting and Indexing Service, 275 Madison Avenue, New York, New York 10016.

> This annual index (with monthly supplements) classifies articles in the following five major oil industry newsletters: (1) Petroleum Intelligence Weekly, 48 West 48th Street, New York City 10036; (2) The Petroleum Economist, 24 Ludgate Hill, London EC4M 7DS, England; (3) Middle East Economic Survey, c/o MEPEP (Cyprus), P.O. Box 4940, Nicosia, Cyprus; (4) Platt's Oilgram News Service, McGraw-Hill, Inc., P.O. Box 1000, Times Square Station, New York City 10020; and (5) The Oil Daily, 320 Campus Drive, Somerset, New Jersey 08873.

Carmichael, Frank R., Offshore Drilling Technology, Noyes Data Corp., Park Ridge, New Jersey, 1975.

> This publication contains technical, equipment-oriented information based on U.S. patents issued since 1967. Chapters include drilling from a floating platform: drilling techniques, equipment guide systems, pipehandling, stabilization; drilling platforms: bottom-supported, floating platforms, arctic construction; wellhead apparatus and connectors: risers and conductor pipes, Christmas trees, well-base structures, wellhead design, flow lines; well completion: completion process, pipeline handling; subsea facilities: satellite systems, submersible vessels and chambers, caissons and buoyant apparatus, other subsea facilities; also included are company index, inventory index, patent index.

Copenhagen Offshore Craft Conference, 1974. Papers organized by Ship and Boat International, edited by Kenneth D. Troup, London: Thomas Reed Industrial Press, Ltd.

Articles include: Aspects of Safety on Offshore Craft; The Drill Ship; Development of Offshore Towing Vessels; Controllable Pitch Propellers in Offshore Industry; Oil Pollution Control Techniques Offshore; Anchoring, Anchor Handling and Towing Winchester for Offshore Industry.

Department of Energy, Mines and Resources, Resource Management and Conservation Branch, Offshore Exploration: Information and Procedures for Offshore Operators, 5th ed., Ottawa, Canada, February 1973.

This is a directory of information on Canadian governmental agencies, organizations and industrial contacts for use by Canadian offshore operators.

Drewry, H.P., Offshore Drilling Rigs. Shipping Consultants, Ltd., London, 1974.

This publication contains a discussion and analysis of a series of indepth reports prepared by Research Development Division of H.P. Drewry (Shipping Consultants) Ltd., on doubts concerning availability of oil from traditional sources leading to the search for oil in more politically secure areas. Quadrupling of crude oil prices has led to expansion of high-cost offshore exploration and production which is economically attractive and politically desirable. This work focuses on the offshore operational advantages and limitations of submersibles, semi-submersibles, jack-ups and drill ships. Also contains mobile offshore drilling rig fleet x type and maximum water; maximum drilling x year of build; water depths x year of build; location; owner; no. on order and delivery date; no. on order x maximum water depth; no. on order x owner; no. on order x builder and country of builder; rig casualties resulting in total loss 1957-73 x area of working 1957-73.

ETA Offshore Seminars, Inc. The Technology of Offshore Drilling, Completion and Production, Petroleum Publishing Company, Tulsa, Oklahoma, 1976.

This book is a collection of articles written by experts in all segments of the offshore drilling industry. The articles cover both introductory aspects of offshore drilling, completion, and production, and more complex technical details helpful to experienced personnel. Topics covered in a total of 21 articles fall into six major categories: factors affecting movement and stability offshore, motion compensation and marine risers, blowout prevention, subsea production and diving operations, drill string testing, and certification and insurance.

Habercom, Guy E., Offshore Drilling: A Bibliography with Abstracts - 1964-1975. NTIS No. N75/PS-75/540.

Abstracts deal mainly with economic, legal, and environmental aspects of offshore drilling. No abstracts include personnel-related or occupational information. (Z-6972.H25)

Harris, L.M., An Introduction to Deepwater Floating Drilling Operations, Petroleum Publishing Company, Tulsa, Oklahoma, 1972.

This is a comprehensive text on deepwater floating drilling covering all aspects of deepwater drilling, from selected vessels and hardware, to safety precautions and personnel. Chapters include: drilling from a floating vessel; planning and organizing; drill vessels;

drilling systems; mooring systems; auxiliary vessels; well-control and communications systems; subsea guide bases; subsea blowout preventers; marine-riser system; drill stem testing; safety and efficiency; future developments.

Hopke, William E. (ed.), Encyclopedia of Careers and Vocational Guidance, Volume I: Planning Your Career and Volume II: Careers and Occupations, Doubleday and Co., Inc., Garden City, New York, in cooperation with J.G. Ferguson Publishing Co., Chicago, Illinois, 1967.

Chapters in Volume I on petroleum industry cover geologists and geophysicists; engineers and chemists; science-trained people; starting jobs and advancement; mechanical trades; other workers; operational control; starting jobs in oil fields; jobs in marketing; opportunities with jobber and oil companies; delivering the products; jobs in management; other opportunities. Volume II covers individual jobs in detail, but not petroleum jobs.

Institute of Civil Engineering, Institute of Structural Engineering, and Society for Underwater Technology, Offshore Structures: Proceedings of Conference held in London, October 7-8, 1974.

Topics include: environment (wave action, design); soil mechanics of seabed; concrete structures (performance); dynamics of offshore structures (loading, structural dynamics); risk factors (accuracy of design process); research requirements (design, classification, calculation); state of art (long-term experience of Central Electricity Generating Board (CEGB) in maintenance and operation of structures).

Kash, D.E., et al., Energy Under the Oceans: A Technological Assessment of Outer Continental Shelf Oil and Gas Operations, University of Oklahoma Press, Norman, Oklahoma, 1974.

This book includes broad coverage of all aspects of offshore drilling including (1) technology assessment (OCS development and research strategy); (2) resource development (developers, regulators, policy-makers); (3) policy issues (adequacy of technology, information and data, environmental quality, government management, jurisdiction); (4) recommendations (plan for OCS development). Appendices include information on pollution and public opinion; pollution and accidents; offshore resources/reserves; leasing procedures; NASA, NAE and University of Oklahoma petroleum study descriptions.

Lohse, A., International Inventory and Forecast of Offshore Petroleum and Mineral Activity, Gulf Universities Research Consortium, Galveston, Texas, 1972.

Report provides an inventory (at end of 1972) of equipment owned by U.S. companies and their foreign subsidiaries used for offshore petroleum and mineral exploration. Included: oceangoing mobile drilling units; support vessels (tugs, crew-boats, supply vessels, geophysical vessels, etc.); special equipment (submersibles, saturation diving systems, deck decompressor chambers, underwater work chambers). Also given are forecasts of offshore oil and gas production; number of wells drilled; mobile drilling unit support vessel requirements; industry trends for 1972-2000.

McWethy, P.J. and Nelson, S., eds., Marine Technology Society Handbook for Offshore Port Planning.

This book includes papers covering broad range of issues in planning for deepwater terminals. Environmental, technical, financial, legal, political aspects are included. This information was incorporated into Marine Technology Society Conference and co-sponsored with Texas A&M and the University of Delaware.

Moore, P.L., Drilling Practices Manual, Petroleum Publishing Company, Tulsa, Oklahoma, 1974.

The general level of proven technology in rotary drilling as of 1974 is covered in this book. The contents are primarily directed towards operations to help them detect and solve problems encountered in drilling. Technical principles of drilling procedures are discussed at length. Numerous exemplary situations are presented with appropriate formulas, data tables, information sources, etc., needed to determine feasible solutions to the problem(s).

Offshore Contractors and Equipment Directory, Petroleum Publishing Co., Tulsa, Oklahoma, 7th edition, 1975.

This publication contains data (in directory listing form) of: drilling contractors and rig owners; construction equipment contractors; geophysical contractors; diving contractors; types of transportation (boats, helicopters, others); also includes an equipment cross reference index of drilling rigs, mobile rigs under construction, construction barges, rig specifications and photographs.

Offshore Operators Committee, Manual of Safe Practices in Offshore Operations, 2nd Revision, New Orleans, Louisiana, January 1972.

This publication is intended to serve as a guide to members of the petroleum industry in developing safe operating practices/procedures compatible with the prevailing circumstances inherent in each individual location and type of location. Very general guidelines are given for the areas of (1) indoctrination and training, (2) emergency procedures/equipment, (3) fire prevention and control, (4) burning and welding, (5) personnel and material transfer, (6) moving mobile units, (7) attending vessels, (8) oil spills, (9) storm procedures, (10) helicopter usage, and (11) crane safety procedures.

Petroleum Extension Service, A Primer of Oilwell Drilling, Third edition, Industrial and Business Training Bureau, Division of Extension, The University of Texas at Austin, 1970.

The book gives an overall view of the procedures and equipment used in drilling for oil and gas. The book is written in language understandable to the layman, but defines terms of the trade. Numerous pictures are provided and a glossary of terms is included.

Petroleum Extension Service, A Primer of Offshore Operations, First Edition, Industrial and Business Training Bureau, Division of Extension, The University of Texas at Austin, 1976.

This relatively new publication in the series of educational materials produced by the Petroleum Extension Service presents an overview of all aspects of offshore drilling operations. It covers both exploratory and production drilling, but places more emphasis on the former. Summary information is presented about MODU transitory modes (navigation and positioning), rig components and procedures peculiar to floaters, routine drilling operations, well control, crews/quarters, and transport to/from shore. Other information presented concerns production drilling.

Petroleum Extension Service, Lessons in Rotary Drilling, Industrial and Business Training Bureau, Division of Extension, The University of Texas at Austin, 35 lesson units, various dates of publication in the 1960s and 1970s.

This set of lessons covers the details of rotary drilling procedures and equipment and is designed to acquaint the new worker on the unit. Unit I, The Rotary Rig and its Components (12 lessons), covers the basic equipment used on the rig. Unit II, Normal Drilling Operations (5 lessons), outlines procedures used to "make hole," including casing/cementing procedures and testing and completion operations. Unit III, Nonroutine Rig Operations (4 lessons), includes topics of controlled directional drilling, open-hole fishing, blowout prevention, and subsea blowout preventers and marine riser systems. Unit IV was prepared by the director of the Business and Industrial Services Department of the University of Oklahoma (Norman, Oklahoma) and contains personnel management information. The lessons are entitled Man Management and Rig Management, and cover aspects of personnel supervision and planning/scheduling/organizing work. Unit V, produced by the Petroleum Extension Service in 1976, covers 6 lessons in Offshore Technology. Topics in each lesson include offshore environmental factors, mooring systems, jacking systems, buoyancy/trim/stability, diving and related equipment, and vessel maintenance and inspection. The last lesson in this series was just completed in late September 1977.

Petroleum Extension Service, Technical Papers from the School of Offshore Operations, Industrial and Business Training Bureau, Division of Extension, The University of Texas at Austin, 3 volumes, 1976-1977.

These volumes contain papers and articles from lectures given at the School of Offshore Operations, one segment of the Petroleum Extension Service educational program. Helpful information is given in these volumes covering topics of marine drilling units, exploratory drilling, mooring procedures, diving equipment and services, subsea completions, fixed platforms, planning for production, marine insurance, oil spills, plus other equipment- and/or procedure-oriented information.

Registro Italiano Navale, Rules for the Construction and Classification of Ships or Platforms for Drilling, Geneva, Switzerland, 1972.

Rules and regulations comparable to American Bureau of Shipping rules.

Society of Naval Architects and Marine Engineers, Proceedings of Spring Meeting, May 25-28, 1971, Honolulu, Hawaii.

Two articles of interest from the Proceedings. "Problems of Ocean Platforms" by M. St. Denis and E. Allmendinger, discusses the fact that platforms involve more perils than ships, because of lack of experience with design. Nautical problems are reviewed such as prediction of environment at sea; winds and currents; provision of stability; minimization of drag; course-keeping ability of towed platforms; adequate seakeepability; incorporation of ample primary strength of hull; danger of dynamic response of jack-up legs; plastic collapse of structure under loading; dynamic stress intensities in drill string and riser; projections of future problems. "Seakeeping Characteristics of a Multi-Unit Ocean Platform," by M.K. Ochi and R.M. Vuolo, theoretically predicts seakeeping characteristics such as motion, hydrodynamic forces and moments of platform by solving the equations of motion in waves.

10th Annual Marine Technology Society Conference, Proceedings. Washington, D.C., September 23-25, 1974. National Needs and Ocean Solutions

These proceedings cover all areas of oil drilling technology. Papers of interest to us include: Offshore drilling and production technology by Brannon, Lyons, and O'Brien; Seal subsea petroleum production systems by Chatas; Subsea oil drilling and completion by Shore and Reeds; articles include information on the development and future trends of equipment and activities: considers vessel, vessel motion; blowout preventive systems; marine riser; environmental influences; factors influencing future development of offshore facilities.

ANNOTATED BIBLIOGRAPHY OF PERIODICALS

Compass, "What's in an offshore drilling rig?" by O.C. Adamsen and R. Gordon MacKenzie, v. 45, no. 3, 1975, p. 1-7.

The type of machinery/equipment used on offshore drilling rigs is discussed.

Engineering News-Record, "Model tests set for deep drilling rig," v. 195, no. 1, July 3, 1975, p. 13.

The article discusses the testing of a $3 million, 370-ft-high scale model of a new type of offshore oil and gas production platform for use in water as deep as 2,000 feet, 35 miles off the Louisiana coast.

Engineering News-Record, "U.S. contractors look offshore at a multibillion-dollar market," v. 195, no. 9, August 28, 1975, p. 14-16.

Within 15 years, more than half of the nation's oil will come from wells drilled off the coast of the lower 48 states and Alaska, compared to about 17 percent now.

Geological Survey, Conservation Division, Outer Continental Shelf Standard No. 1 (GSS-OCS-1), First Edition: "Safety Requirements for Drilling in a Hydrogen Sulfide Environment." Washington, D.C., The U.S. Department of the Interior, February 1976.

The purpose of this document is stated as being "to define the safety precautions required for drilling operations where hydrogen sulfide gas (H_2S) will be encountered in known reservoirs and required preventive measures for the detection and control of the hazard in unknown reservoirs on the Outer Continental Shelf." The document covers personnel safety and protection procedures, equipment considerations, suitable drilling muds, proper procedures to follow for common drilling operations (including protective devices to be worn), kick detection and well control, and well testing in an H_2S environment.

Marine Technology Society Journal, "Effects of an offshore crude oil unloading terminal on the marine environment," by Wesley P. James, Roy W. Hann, Jr., and Frank Slowey, v. 9, no. 1, January 1975, p. 27-31.

Information in this article covers facilities, construction schedule, field sampling program, impact of construction, impact of normal operation and maintenance, oil spills. References, p. 31.

New Scientist (Great Britain), "When will oil platform fail?", A. Walker and P. Sibley, v. 60, no. 987, February 12, 1976, p. 326.

Designers increased the size of box girder bridges, concrete cooling towers, and cast iron bridges until an example of each finally collapsed. The same thing is likely to happen to oil platforms, for the same reason: the technology is being extended far beyond the validity of simple design tests. Top designers in the field admitted that they do not understand the dynamic forces that the North Sea puts on their platforms.

Ocean Industry, "Ocean Industry's Report on Construction Activities," v. 11, no. 1, January 1976, p. 61-84.

This article presents in tabular form the characteristics of all platforms, terminals and buoys, submersibles, drillships, semisubmersibles, jack-ups, lay and derrick barges, marine support vessels, and seafloor production systems which are presently under construction or planned to be constructed.

Ocean Industry, "1976-77 Directory of Marine Drilling Rigs," v. 11, no. 9, September 1976, p. 35-168.

This directory includes data on each individual semisubmersible, drill ship, drill barge, jack-up, and submersible unit in operation, temporarily idle, or currently under construction. Photographs are included.

Ocean Industry, "Offshore Europe '75," v. 10, no. 8, August 1975, entire issue.

Articles include: What's going on in the North Sea; Key components in $350 million complex installed in North Sea; New licenses will spur Irish oil, gas search; Seaway Falcon - new North Sea utility firefighter vessel; French begin exploration of Western Approaches basin; Slipform tested for deep water platform; Unmanned vehicle makes subsea inspections; New design: floating concrete production platform; Seaway orders semisubmersible maintenance-diving-support vessel; Concrete production platform will have 1-million-bbl storage capacity; Restrictions on diving in Danish waters; Platform components that can be combined for many applications; Financing required to develop Norway's North Sea sector; Steady pounding of North Sea ages platforms; Institute teaches structural analysis to offshore engineers; Soviets will explore Caspian Sea with French-built drillship; new insight into decompression sickness.

Oceanus, "Atlantic offshore oil," by James M. Friedman, v. 19, no. 1, Fall 1975, p. 22-31.

This article discusses the need for planning and regulations in offshore drilling operations in the Atlantic Ocean.

Offshore (annual worldwide drilling and production issue), v. 35, no. 7, June 20, 1976, entire issue.

Information includes: A statistical section giving counts of offshore wells drilled, largest fields, types of offshore wells, production by nation, and exploratory and development wells; articles on drilling activities in the Western Hemisphere (Gulf of Mexico, U.S. East and West Coasts, Antarctica, Canada, Latin America) and in the Eastern Hemisphere (North Sea, Mediterranean, Ireland, Middle East, Africa, Australia, Sri Lanka, Southeast Asia and India).

Offshore (annual worldwide drilling and production issue), v. 35, no. 7, June 20, 1975, entire issue.

Information includes: The pace of development of offshore activities; worldwide rig activity map; map of leases and concessions in the Gulf of Mexico; worldwide statistics; five years drilling survey; offshore drilling 1974; offshore crude production; offshore gas production; offshore reserves; worldwide production platforms; worldwide offshore acreage; 100 largest offshore fields, Western Hemisphere and Eastern Hemisphere.

Offshore, "Offshore Technology Conference, '75," v. 35, no. 5, May 1975, p. 101-108, 111+.

The article reviews the areas covered in the technical sessions of the seventh annual Offshore Technology Conference, held May 5-8, 1975, at Houston. It mentions topics of technical papers presented and topics highlighted at technical sessions.

Offshore, "New, innovative designs for jack-ups for the North Sea oil patch," v. 34, no. 4, April 1974, p. 92, 95-96+.

This article calls into question past design concepts in light of increasing performance demands made on offshore drilling units and higher construction costs.

Offshore, "Supply and transportation," v. 34, no. 3, March 1974, p. 49-56, 58+.

Various articles cover topics such as the growth of the boat industry and its changes to meet the needs of the offshore industry; information on the number and new construction counts for vessels in service to the worldwide offshore petroleum industry; problems with the availability of offshore personnel; and the use of air cushion vehicles along with helicopters and crewboats in the Gulf.

Offshore Rig Data Services, "The Offshore Rig Location Report, September 1977." Houston, Texas: The Sheffer Company.

This report is published monthly to show the worldwide activity of mobile and fixed offshore drilling units. Twenty-seven geographical areas of activity are shown. Ten data items are identified for each unit: owner, unit name and rated water depth, operator, location (specific body of water), water depth, target drilling depth, spud date, names of subcontractors used, shore base, and future status of contact.

Sea Power, "The new gargantuans of the deep," by Edward F. Oliver, v. 18, no. 8, August 1975, p. 16-21.

Increasing demands for oil have brought about a revolution in rigs designed for offshore drilling - mobile units designed for use in turbulent deep-ocean waters. The jack-up, the semi-submersible, and the drill ship are all briefly discussed.

Shipping World & Shipbuilder (Great Britian), "Offshore industry feature," v. 168, no. 3901, January 1975, p. 99, 103-105+.

Topics include: The (bright) future for offshore oil; Sullom Voe-megaport of the 1980's - project for East Shetland oilfield terminal; a review of concrete production platforms; offshore platform communications; a new concept in single point buoy mooring; offshore supply vessels; a wide variety of sophisticated designs; combined navigation/surveillance radar for drilling rigs; offshore developments; offshore equipment.

World Oil, "Offshore '75," v. 181, no. 1, July 1975, p. 61-97.

Articles include: Exploration is moving into deeper waters, by Robert E. King; How five major bid factors affect potential lease profit, by Robert O. Hubbell and Gordon A. Derouen; Latest drilling equipment is onboard Pentagone 84, by Philippe Tricot; Special working areas boost personnel efficiency, by Gilles Pouget; Intricate processing yields accurate penetration rates, by Andre Delestrade and Philippe Tricot; Well Control apparatus is rated for 15,000 psi WP, by Philippe Tricot; Propulsion system assists conventional mooring, towing, by Bernard Cintract; Platform technology spurred by deep-water developments, by Robert E. Snyder; Unique semi's dominate rig designs; What's new in production operations; Hostile environment spur innovations in drilling, by T.R. Wright, Jr.

World Oil, "Offshore in '74," v. 197, no. 1, July 1974, p. 79-105, 108.

Articles include: Ice platform, subsea methods used for Arctic Ocean well; Marine exploration advances emphasize seismic technology; Hectic platform activity dominates production scene; New technology is aimed at boosting drilling efficiency; Subsea production systems close to being operational; advanced controls and tools will cut development costs; How dynamic positioning works on drill ship "Pelican"; $3.4 billion exposed in Texas offshore lease sale.

SECTION C: LIST OF COURSES AND SCHOOLS AVAILABLE FOR OFFSHORE DRILLING PERSONNEL

9-27-77

INTERNATIONAL ASSOCIATION OF DRILLING CONTRACTORS CO-SPONSORED SCHOOLS FOR THE OIL AND GAS DRILLING INDUSTRY

SCHOOLS	SUBJECT	LOCATION	COST	LENGTH	CONTACT
BASIC DRILLING					
Elementary Drilling Technology	Basic Exploration & Well Completion	Odessa,TX	$150	1 Week	Petroleum Extension Service, College Box 176, P.O. Box 3752, Odessa, TX 79760 (915)337-8042
Introduction to Offshore Operations	Basic Drilling Offshore Ops.	Kilgore, TX or where req.	$150	1 Week	Petroleum Extension Service, 1100 Broadway, Kilgore, TX 75662 (214) 984-8689
ENTRY LEVEL FLOORMEN					
Entry Level Floormen Training	Beginner Floormen Trng.	Thibodaux,LA	-0-	4 Weeks	Jim Olson,Nicholls State University,Box 2057 University Station, Thibodaux,LA 70301 (504) 446-8111, Ext. 1602
Drilling Personnel Training Program	Beginner Floormen Trng.	Corpus Christi	$100	4 Weeks	M.E. Maurer, Del Mar College, Baldwin at Ayers, Corpus Christi, TX 78404 (512)882-6231
INTERMEDIATE DRILLING					
School of Drilling Technology	Modern Drilling Techniques	Odessa,TX	$350	4 Weeks	Petroleum Extension Service, College Box 176, P.O. Box 3752, Odessa, TX 79760 (915)337-8042
Gulf Coast School of Drilling Practices	Modern Drilling Techniques	Lafayette,LA	$300	4 Weeks	Gulf Coast School of Drilling Practices, USL Box 4-0635, Lafayette, LA 70504 (318)233-8005
ADVANCED DRILLING					
School of Offshore Operation	Ops. of Offshore Drlg.	Baytown,TX	$250	2 Weeks	Petroleum Extension Service, Drawer S-University Station, Austin, TX 78712 (512)471-7447
School for Drillers & Toolpushers	Basic Drilling Engineering	Odessa,TX or where req.	$175	1 Week	Petroleum Extension Service, College Box 176, P.O. Box 3752, Odessa, TX 79760 (915)337-8042
School of Drilling Engineering	Adv. Drilling Engineering	Austin, TX	$400	2 Weeks	Petroleum Extension Service, Drawer S, University Station, Austin, TX 78712 (512)471-7447
BLOWOUT PREVENTION					
IADC Blowout Control Center	Initial Well Control Procedure Course	Baton Rouge LA	$400	3 Days	Prof.Bill Hise,IADC Blowout Prevention School, Rm.43B Pleasant Hall, Baton Rouge, LA 70803 (504) 388-6058

INTERNATIONAL ASSOCIATION OF DRILLING CONTRACTORS CO-SPONSORED SCHOOLS
FOR
THE OIL AND GAS DRILLING INDUSTRY

SCHOOLS	SUBJECT	LOCATION	COST	LENGTH	CONTACT
BLOWOUT PREVENTION Cont'd					
Oilwell Blowout Prevention Systems	Initial Well Control Procedure Course	Norman, OK	$400	3 Days	Mr. Reg Hibberts, IADC Oilwell Blowout Prevention School, University of Oklahoma, Bldg. 31-South Campus, Norman, OK 73019 (405)325-3946
Blowout Prevention Refresher Course	Kick-Control w/Simulator	Lafayette, LA or where req	$160	2 Days	Gulf Coast School of Drilling Practices, Petroleum Trng. Service, USL Box 4-3372, Lafayette, LA 70504 (318) 233-8005
Blowout Prevention Refresher Course	Kick-Control w/Simulator	Beaumont, TX or where req	not set	2 Days	Petroleum Extension Service, Drawer S-University Station, Austin, TX 78712 (512)471-7447
MAINTENANCE					
School of Rig Mechanics	Engine Repair	Kilgore, TX	$150	1 Week	Petroleum Extension Service, 1100 Broadway, Kilgore, TX 75662 (214) 984-8689
School of Rig Maintenance Technology	Mech. Components & Sup. Systems Repair	Kilgore, TX	$300	2 Weeks	Petroleum Extension Service, 1100 Broadway, Kilgore, TX 75662 (214) 984-8689
School of Rig Electricians	Elec. Equipment Repair	Kilgore, TX	$250	2 Weeks	Petroleum Extension Service, 1100 Broadway, Kilgore, TX 75662 (214) 984-8689
SUPERVISION					
Field Level Supervisory Course for Drlg. Contrac.	Fundamentals of Supervision	Norman, OK	$100	1 Week	Mr. W.I. Hartman, University of Oklahoma OCCE, 1700 Asp Ave., Norman, OK 73037 (405)325-1931
SAFETY					
Field Level Supervisors Safety Course	Fundamentals of Safety	Norman, OK	$100	2 Days	Mr. W.I. Hartman, University of Oklahoma OCCE, 1700 Asp Ave., Norman, OK 73037 (405)325-1931

NOTE: ALL SCHOOLS REQUIRE A PROFICIENCY IN ENGLISH

1977 CALENDAR OF
INDUSTRIAL AND PROFESSIONAL SCHOOLS
(Courtesy of Santa Fe Drilling and Marine, Houma, Louisiana)

School	Course
Ansul Fire Training School	Fire Fighting
Caterpillar Tractor Company	User Master Mechanic, Marine/Petroleum Level III
Dresser Oilfield Products Division	Magcobar Mud Training School
General Electric Atlanta, Georgia	Oilwell Drilling Rig Drive Systems (SCR)
General Motors, Electro-Motive Division, La Grange, Illinois	Stationary Engine
Honeywell Incorporated, Marine Systems Division	Acoustic Position, Reference System, RS5/505
Hunt Engine Company	EMD Engines: Operation, Maintenance and Troubleshooting Procedures
Hydro Products	Subsea TV Equipment Maintenance and Operation
Louisiana State University	Prevention of Oil and Gas Well Blowouts
Manitowoc Engineering Company	Manitowoc Crane Service School
Marathon Le Tourneau	Operation and Service Training School for Owners and Operators of Mobile Offshore Platforms
Martin-Decker Company	Mud Functions-Drilling Functions and Wireline Functions
Mechanical Equipment Company	Water Distillation Unit Operation and Maintenance
Mustang Tractor and Equipment Company	D398 and D399 Caterpillar Engines
Preston L. Moore, Inc.	Drilling Practices School
Ross Hill Controls Corp.	SCR Drive System

School	Course
Rucker Control Systems Co.	Comprehensive Training Seminar
Sig Harris Floating Drilling School	Floating Drilling School
Southern Methodist University Institute of Management	Management of Oilwell Drilling Firms, Modern Techniques of Supervision
Stewart and Stevenson Oiltools, Inc. (Koomey)	Koomey Comprehensive Hydraulic Subsea School
Texas A.&M. University	Advanced Drilling Engineering
University of Oklahoma	Oilwell Blowout Prevention Systems, Field Level Supervisory Course for the Drilling Contractor, Supervisor's Conference on Accident Prevention; Supervisor's Conference on Fundamentals of Supervision
University of Southwestern Louisiana	Gulf Coast School of Drilling Practices, Well Control School
University of Texas	Refresher Course in Blowout Prevention
U.S. Department of Commerce, Maritime Administration	Damage Control & Fire Fighting, Ocean and Great Lakes Radar Observer
Vetco Offshore, Inc.	Comprehensive I, Comprehensive II, Offshore Completion; Mechanical Training
Woodward Governors Co.	Governors and Controls
Young Memorial Vocational Technical Institute	Able Seaman/Lifeboatman/Tankerman

SECTION D: FUNCTIONAL JOB ANALYSIS (FJA) METHOD

FUNCTIONAL JOB ANALYSIS (FJA)

BACKGROUND

This section on FJA procedures is excerpted from ORI Technical Report 1012, Handbook for the Development of Qualifications for Personnel in New Technology Systems, February 1976. It describes the methods and guidelines used to construct FJA task statements. The content of the material used in some of the example statements relates to functions of cargo handling personnel on Liquid Natural Gas (LNG) tankers.

FJA TASK STATEMENT

The FJA task statement format is illustrated in Figure D.1. As shown in this figure through the means of circled numbers, a complete task statement has nine parts:

1. Goal to which the task contributes.

2. Objective to which the task contributes.

3. A description of the task, written according to a prescribed format to include a standard set of content elements.

4. Measures of the level of the involvement with data, people, and things, i.e., the complexity of the worker's action with respect to data, people, and things. Complexity is determined from scaled descriptions that have numerical ratings assigned to them. (See Section E.)

5. Measures of the orientation of the worker's function in the task, i.e., extent to which it involves the worker with data, people, and things. The extent of involvement of each kind is expressed as a percentage.

TASK CODE: CO-II.A.1

WORKER FUNCTION LEVEL AND ORIENTATION						WORKER INSTRUCTIONS 6	GENERAL EDUCATIONAL DEVELOPMENT		
4 DATA	5 %	4 PEOPLE	5 %	4 THINGS	5 %		7 REASONING	7 MATH	7 LANGUAGE
3B	65	2	5	1A	30	3	3	1	2

TASK CODE: CO-II.A.1 GOAL: To discharge LNG safely. 1

OBJECTIVE: 2 To place the vessel in a condition suitable for the discharging of LNG.

TASK: 3 Periodically, visually inspect and check the mooring system in order to ensure that the vessel is moored in accordance with the mooring arrangement diagrams for the specific loading terminal, using your own judgment as to anticipated wind and sea conditions and known strength and conditions of the mooring lines.

8 PERFORMANCE STANDARDS	9 TRAINING CONTENT
<u>Descriptive</u>: • Mooring lines are taut without any line being over-stressed. • "Badly worn" mooring lines are not used. • Safety considerations are maximized. <u>Numerical</u>: • In 100% of the cases, the vessel is moored in accordance with the mooring arrangement diagram. • The mooring lines are inspected at least once every three (3) hours. • In 100% of the cases, the vessel's mooring system withstands forces caused by sudden and/or extreme changes in wind/sea conditions.	<u>Functional</u>: • How to evaluate by experience, weather report, or barometric pressure, the forces on a moored ship with respect to wind/sea conditions. • How to compensate for "aged" or "slightly worn" mooring lines. • How to recognize the different types of mooring lines as well as their individual capabilities and limitations. • How to read mooring arrangement diagrams. <u>Specific</u>: • Knowledge of the vessel's mooring lines. • Knowledge of the specific mooring arrangement diagram for specific loading terminal.

FIGURE D.1. EXAMPLE OF AN FJA TASK STATEMENT

6. An indicator of the level of complexity of the instructions the worker must follow. Level of instructions is also given a numerical rating according to a complexity scale. (See Section E.)

7. Indicators of the general education development (GED) required to do the task, i.e., the level of language, math, and reasoning skills. These levels are also given numerical ratings according to complexity scales. (See Section E.)

8. Performance standards-the criteria by which performance will be evaluated.

9. Training content-what the worker has to know and be trained to do to perform the task to the standards indicated.

The terms "task statement" and "task statement form" refer to all nine parts or their documentation. "Task description" is the verbal statement of the task only. Figure D.1 shows how a completed task statement looks.

The development of each part is initiated in the order in which it has been listed. However, feedback is a basic part of the FJA process. As the analyst considers task orientation, he may realize that his writeup of the task description emphasizes the wrong orientation. The task may be primarily an interaction with people but, because filling out a form is involved, the analyst may have written the task so that it sounds like a data oriented task. The scale ratings for the complexity of task content, instructions, and language/reasoning/math skills similarly provide checks on the accuracy of the task description.

The goals and objectives will have already been defined in the process of delineating system functions. Those goals and objectives are recorded on the task statement forms as appropriate.

Tasks are identified for each objective. The analyst now uses the structure and language prescribed by FJA to write a complete description of each task. The analysis goes on to complete the other parts of the task statement in turn, using each as a check on the veracity of the preceding parts. When a task statement is well done, the parts complement each other-they make a sensible and logical whole.

It is recommended that task statements be prepared in sets by objective. It is also recommended that a complete statement be prepared for each task before another statement is begun.

The processes of describing the tasks and completing the remainder of the task statement form are explained individually in the following paragraphs. It should be remembered that in the actual performance of this process, the analyst will freely look back to check and adjust preceding parts.

Task Description

The quality of the task statement as a whole flows from the quality of the task description. Consistency, clarity and comparability of task descriptions result from:

- Controlled content elements
- Controlled language to describe content elements.

The FJA procedure provides for both. The developers of FJA have this to say about required content elements: "The two most important elements of a task statement are:

1. The action the worker is expected to perform.
   Example: Asks questions, listens to responses, and writes answers on standard forms.

2. The result expected of the worker action.
   Example: To record basic identifying information such as name, address, etc."

> "The worker action(s) phrase in the task description represents the worker's activity as concretely as possible. The result phrase describes explicitly what his action is expected to produce or what gets done, which identifies the worker's concrete contribution to a process or work system objective. Although action and result are the two most critical elements in a task description, and can be thought of as the skeleton of a task, the description must include additional items of information to communicate clearly and consistently." (Fine and Wiley, 1971)

Figure D.2 is a checklist excerpted from Fine and Wiley (1971) that states all of the information needed in a task description.

Use of a model sentence such as that shown in Figure D.3 will ensure that all necessary items of information are included.

The use of language is also important in FJA. Writing task descriptions requires practice in the precise use of terms. The reader of a task should be able to visualize the task clearly.

The choice of action words in a task description affects its clarity the most. There is a tendency to use end result verbs instead of explicit action verbs. Whenever an end result verb is used, the worker action is obscured. For example:

- (Worker), trim the vessel in order to position it in the trim condition for LNG cargo loading operations...

1. Who? (Subject)

The subject of a task description is understood to be simply "worker." The description contains no subject since it is always assumed to be "worker."

2. Performs what action? (Action Verb and Object)

A task description requires a concrete, explicit action verb. Verbs which point to a process (such as develops, prepares, interviews counsels, evaluates and assesses) should be avoided or used only to designate broad processes, methods, or techniques which are then broken down into explicit, discrete action verbs.

3. To accomplish what immediate results?

The purpose of the action performed must be explicit so that (1) its relation to a system objective is clear and (2) performance standards for the worker can be set.

Result: To determine whether they have been securely joined, for transfer of LNG from terminal to ship tanks. The objective to which this result is directed is: Safe loading of LNG within scheduled time.

4. With what tools, equipment, or work aids?

A task description should identify the tangible instrumentation a worker uses as he performs a task: for example, telephone, pencil/paper, checklists, written guides, wrench, etc.

Tools: In this example, the worker uses no tools.

5. Upon what instructions?

A task description should reflect the nature and source of instructions the worker receives. It should indicate what in the task is prescribed by a superior and what is left to the worker's discretion or choice.

Prescribed content: According to equipment specifications for transfer line connections.

Discretionary content: Exercising some leeway as to sequence and timing of inspection.

FIGURE D.2. FJA CHECKLIST FOR WRITING TASK DESCRIPTIONS

Worker, please ________, ________, and ________	(action)
In order to ________	(result)
Using ________	(tools, equipment, work aids)
Following ________	(prescribed instructions)
Using *your own judgment* as to ________	(what is left to worker's discretion)

FIGURE D.3. MODEL SENTENCE FOR TASK DESCRIPTIONS

Trim condition is the desired result of the worker action. The result was turned into a verb for the task description. It might just as well read "Do whatever is necessary in order to put the vessel in trim condition..."

The task description can be rewritten to clarify the worker's action (and result as well) as follows:

- (Worker), operate controls of the saltwater ballast system from the cargo control room, discharging ballast in order to maintain a prescribed mean draft and position the vessel in trim condition for LNG cargo loading operations...

FJA provides guidelines for an action vocabulary in the worker functional orientation scales, shown in Section E.

Technical terminology is permissible as long as the terminology will be meaningful to anyone working in the field. This is the main criterion:

- If a worker read or heard the task description would he identify with it and recognize the task as his own? When the worker reads or hears the task description his thoughts should be, "Yes, that's what I do," not "Is <u>that</u> what I do?"

Analysts who have experience in the field have a great advantage in being familiar with the terminology. It helps them identify and use source information more readily for task writing and helps them write tasks that ring

true. However, the terminology can be a trap because it is assumed to have greater precision than common language. Specialized terminology can mean different things to different people and in different contexts. For example, anyone involved with ships is probably going to know what "trim condition" means (in the last example task description). That is a good use of the term; it evokes immediately an image that might be lost in verbiage if the analyst tried to explain it in common language. However, "trim" as a verb is not so clear. The action of trimming is different for different types of vessels. The error, however, was not in the use of specialized language; it was in the confusion of action with result. Experience indicates that awareness of this action/result distinction tends to eliminate problems concerning the use of terminology of the field. Most special terms originate as nouns; they are names given to results, products, processes. When those are turned into verbs, essential differences in the actions may be obscured.

Figure D.4 shows the development of a task description written by a new task analyst and critiqued by peers. The third draft provides significantly more information about what the worker does. The first draft focused on the expected result too much. In the third draft it is clear that the task is very simple--just turn dials and push buttons as directed by a short, step-by step procedure that does not have to be remembered, observe whether panel lights respond as they should, and record the completion of the task in a log. Figure D.4 also demonstrates that there is some leeway in using the model sentence. In the example task the tools/equipment/materials are not specified in a distinct "using what" clause. The work aids are the vapor detection console, the procedure mounted on it, the worker's own hands and eyes, the log, and a pen or pencil. Those are all clearly indicated in other elements of the task description. The primary purpose of the model sentence is to help the analyst make sure he considers all the elements of a task.

Summary of Task Description Process.

1. Select subsystem, goal, and objective.

2. Select task.

3. Use model sentence to write description of task in the most precise language possible.

4. Get someone to read the task description. Determine whether all elements are clear to the reader. Revise as indicated. (Feedback from a reader is very helpful when beginning to write task descriptions. As the analyst gains experience, he can omit this step since FJA includes two editing processes in which feedback will be obtained.)

5. **When the task description seems adequate, write it in the task space on the task statement form and go to the next process.**

MODEL SENTENCE FOR TASK DESCRIPTIONS

Worker, please ____________, ____________, and ______________ (action)

In order to ____ (result)

Using ____. (tools, equipment, work aids)

Following ____ (prescribed instructions)

Using your own judgment as to ______________________ (what is left to worker's discretion)

TASK DESCRIPTION

(First Draft)	Test the salinity detection system in order to ascertain that audio-visual alarms are functioning, using the test panel on the evaporator control console, following the procedure outlined thereon, using your own judgment as to testing more sample points than required thereon.
(Second Draft)	Test the salinity detection system in order to visually check and record in log that the audio-visual alarms are functioning, using the test panel on the evaporation control console, following the 5-step sequential procedure mounted on the console and using your own judgment as to testing more sample points than required thereon.
(Third Draft)	Turn dials, push buttons, observe and sign off in log as to response of audio and visual signals on the salinity detection test panel in the engineroom, in order to verify that audio and visual alarms are working, following 5-step sequential procedure mounted on the test panel and using your own judgment as to whether to test more than the required sample of test points.

FIGURE D.4. EXAMPLE OF THE DEVELOPMENT OF A TASK DESCRIPTION

Assessment of Task Functional Level and Orientation

After writing the task description, the analyst is then faced with assessment of the functional level and orientation of the task. The following explanation of this step is adapted from Fine and Wiley's Functional Job Analysis (1971), referenced previously.

What workers do as they perform the tasks that make up their jobs, they do in relation to Data, People, and Things. All jobs involve the workers, to some extent, with information or ideas (Data), with clients or co-workers, (People), and with machines or equipment (Things). Workers function in unique ways in each of these areas. For example, when a worker's task involves him with machines or equipment (Things), the worker draws upon his physical resources (strength, dexterity, motor coordination, etc.). When a worker's task involves him with information or ideas (Data), the worker calls his mental resources into play (knowledge, thought, intuition, insight, etc.). When a worker's task involves him with clients, customers, and co-workers (People), the worker draws upon his interpersonal resources (empathy, courtesy, warmth, openness, guile, etc.). All jobs require the worker to relate to each of these areas and in doing so require him to draw upon his resources in each of these areas to some degree.

The concrete and specific actions which workers perform in relation to Data, People, and Things as they execute different tasks can probably be described in an infinite number of ways; that is, there are as many specific ways of expressing what workers do in relation to Data, People, and Things as there are specific tasks to be performed or unique content conditions to which there is only a handful of significant patterns of behavior (functions) which describe how workers use themselves in relation to Data, People and Things. Those patterns of behavior which can be articulated reliably have been defined in Worker Function Scales, among the primary tools of FJA, which provide a standardized, controlled language to describe what workers do in the entire universe of work. For example:

- In relation to information and ideas, a worker functions to compare, compile, compute, or analyze data.

- In interacting with clients, customers, and co-workers, workers serve, exchange information, coach, or consult with people.

- In using equipment, workers feed, tend, operate or set up machines and drive/control vehicles. Although each of these worker functions is performed under widely varying conditions, occurs over a range of difficulty, and involves different specific content, each, within its scope, calls for similar kinds and degrees of worker characteristics to achieve effective performance.

The functions in each of the three areas of Data, People, and Things, are defined by a Worker Function Scale, in which the performance requirements range from the simple to the complex. The scale is ordinal (that is, one in which any point on the scale includes lower levels and excludes higher levels). Thus the selection of a specific function to reflect the requirements of a particular task indicates that the task includes the lower functions and excludes the higher ones. Figure D.5 illustrates this concept. The complete Worker Function Scales are included in Section E. When scanning the Worker Function Scale for Data (for example), if the analyst selects the compiling function as the appropriate worker behavior to describe the way a worker must relate to information in a given task, he is deciding two things: (1) that the worker's performance is more complex than copying and less complex than analyzing; and (2) that the worker must be able to perform all or at least comprehend all the data functions below compiling, but does not have to be able to perform or comprehend higher functions such as analyzing or coordinating.

OVERVIEW OF WORKER FUNCTION SCALES

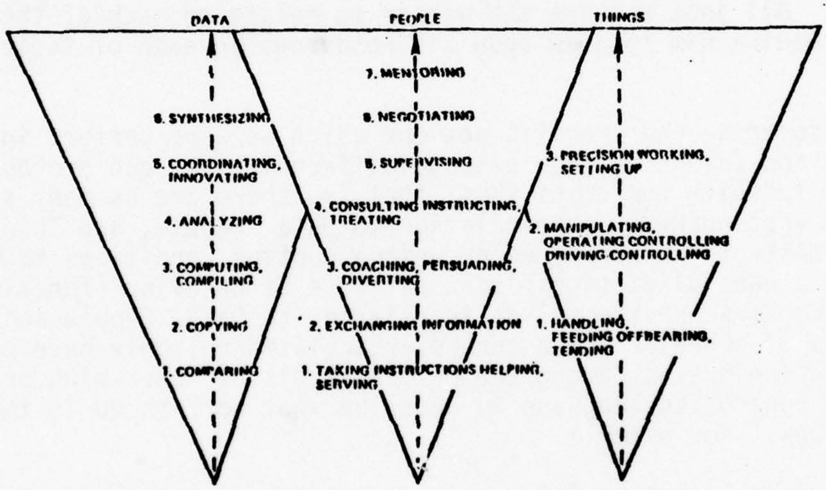

FIGURE D.5. SUMMARY CHART OF WORKER FUNCTION SCALES

The three hierarchies of Data, People, and Things functions provide two measures for systematically comparing and measuring the requirements of any task in any job. These two measures are level and orientation.

The level measure indicates the relative complexity or simplicity of a task when it compared to other tasks. It is expressed by selecting the function that best describes the pattern of behavior in which the worker engages to perform a given task effectively. The ordinal position of the function is the level measure. For example, to say that a worker in dealing with the Data content of a task is compiling, one has indicated that he is functioning at level 3B on the Data scale as shown in Section E. This requires a

higher level of functioning than is required in copying information (level 2) but is a lower level function than is required for analyzing data (level 4).

The orientation measure provided by FJA indicates the relative involvement of the worker with Data, People, and Things as he perform a given task. (Emphasis supplied.) The worker is not equally involved with all three in any task and his relative involvement with any of the three may change from task to task. For example, in performing one task in his job, a worker may be involved almost exclusively with Data; that is, something like 75 percent of his involvement and the resources he draws upon to perform a task are related to Data at the compiling level; but in order to accomplish the task, he must also be involved interpersonally in exchanging information with co-workers (perhaps 15 percent) as well as in calling upon physical resources in handling various documents, paper, and pen (10 percent). The worker's total functional involvement with Data (75 percent), People (15 percent) and Things (10) percent) adds up to 100 percent.

The orientation measure, then, is expressed by assigning a percentage in units of 5 or 10 to each of the three functions so that the total adds up to 100 percent. Note that these percentages are estimates. The reliability sought is in the pattern and proportion of the three estimates, not in the absolute amount of the estimates. (Emphasis supplied.)

The orientation measure is a reflection of the performance requirements of a task. In the example above, the estimates assigned must be in accord with the independent judgment that this task will be evaluated overwhelmingly on its data standards and quite lightly with regard to its people and things standards. The training the worker must have to perform the task should emphasize and build the mental skill required. The supervisor's instructions to the worker should emphasize and reflect the nature of the mental performance expected and the data standards by which the worker's results will be judged.

From the application of FJA to new technology ship occupations, some additional guidelines have been developed to assit in clarifying the FJA orientation measure.

The measure is seen as an indicator of the degree of worker concentration that is appropriate for the Data, People, and Things functions, relative to each other. The predominant function of a task, which should be foremost in the worker's awareness, is indicated by the desired result of the task. The relative prominence of the subordinate functions is suggested by the resources used to accomplish the task, how much they are used, and the care/precision with which they must be used in order to achieve the result. Task results can be categorized as data-, people-, or things-oriented. Task resources consist of data, people, and things.

The task described in Figure D.4 may be used as an example. The intended result of the task is verification of whether a system works. That is a data-oriented result. Thus the worker should focus on the data function in this task and the percentage which expresses the degree of the worker's

orientation toward data should be greater than the percentage expressing his orientation toward people or things.

Continuing with the example task, the worker must use things directly and deliberately, to accomplish the task result. He manipulates switches/buttons on a control panel according to a procedure. Thus he needs to concentrate on things to a substantial degree, although to a lesser degree than on the data function. The people function in this task should require minimal concentration. It consists of following instructions that in this case would be standing instructions. No personal interaction need occur.

The measure of the appropriate orientation to people in this task would be the least allowable percentage of the hypothetical total orientation -- i.e., 5%. That leaves 95% to be allocated to data and things. The data orientation receives the greater portion because the task is being performed to obtain data. Thus (given the rule of increments of 5%), the data orientation must be at least 50%. A things orientation of at least one-third is warranted, since the worker has to use things in a direct and premeditated way in order to generate the data by which the task result can be accomplished. With those boundaries, the data orientation should be in the range from 50% to 60%, and the things orientation in the range from 35% to 45%.

Hopefully, the foregoing will not suggest that determining orientation measure need involve an arduous and time-consuming thinking process. These measures typically are decided quickly, and equivalent measures (± 10%) are typically selected by different people, provided that the task is described clearly. The process is in essence intuitive.

It is stressed that the orientation measures are intended to establish the appropriate relative weights of the Data, People, and Things Functions in a task. The orientation measures indicate where emphasis should be placed in training, task performance, and performance evaluation.

Steps in Assessing Task Level and Orientation.

1. Scan the appropriate Worker Function Scale in Section E. A new analyst should read the scale completely through.

2. Compare the level definitions to the worker action phrase in the task description. (It may be necessary to revise the task description at this point.)

3. Select the level definition that best fits the worker's actions in relation to the function under consideration.

4. Record the level rating in the space for it on the Task Statement Form.

(Do steps 1-4 for each functional area -- Data, People, and Things.)

5. Assign a percentage for orientation to Data, to People and to Things. Record the percentages in the spaces for them on the Task Statement Form.

When beginning to write task statements it is helpful to get one or more independent assessments of the level and orientation of the task. The independent readers should make their assessments and then discuss them. The task should be then reworded if necessary and reassessed until an agreement is reached (difference no more than one level on scale and no more than 5 percent in oridentation). Agreement tends to indicate the accuracy of the task description.

Assessment of Instructional Level

The next step toward the completion of the task statement deals with worker instructions. All work is a mix of precription and discretion; whatever is not prescribed is discretionary. High level tasks have a greater proportion of discretion in relation to the prescription.

The prescribed and discretionary mix of work is described in FJA by an ordinal scale called the Worker Instructions Scale. It will be found following the Worker Function Scales in Section E, following this section. The new analyst should read this Worker Instructions Scale fully to become familiar with its categories before trying to use it.

Each task description contains information about the instructions the worker received (the prescription) and what is left to the worker to decide (discretion). This information should be adequate to permit the analyst to determine the level of instructions on the Worker Instructions Scale. To illustrate, the instructions part of the sample task description (Figure D.4) reads as follows:

> ... following the 5-step sequential procedure mounted on the test panel and using your own judgment as to whether to test more than the required sample of test points.

Referring to Section E, these would be level 2 instructions. As stated in the scale definition for level 2, the "inputs and outputs are all specified, but the worker has some leeway about the procedures and methods he can use to get the job done." (Worker decides whether there is a need, and time, to test more than the required sample, and no time for testing is prescribed -- the worker usually decides at what time to do this daily task.) "Almost all the information he needs is in his assignment." (The information needed to decide whether to do more testing comes from the worker's experience; also, when to test may be determined by other conditions.)

The instructions rating should be compared to the data rating selected from the Worker Function Scale for Data. If there is a difference of more than one level between those two ratings, the two ratings should be rechecked. High-level instructions are not appropriate for a low-level data task, and vice versa.

Summary of Steps in Assessing Worker Instructions.

1. Scan the Worker Instructions Scale in Section E of this report. (A new analyst should read the scale completely through.)

2. Compare the level definitions to the phrase describing instructions in the task description.

3. Select the level definition that best fits the mix of prescription and discretion indicated by the task description.

4. Compare instructions level to data function level; reassess one or both if there is more than one level of difference between the ratings.

5. Revise task description if that is called for, and reassess.

6. Record the level of instructions (and the new data function level, if it has been revised) on the task statement form.

As with the Worker Function Scales, it is helpful in learning to use the Worker Instructions Scale to get an independent reader or readers to apply the scale to the task description. If the independent assessment does not agree with the analyst's (same rating or one level higher or lower), then both assessments and the wording of the task description should be discussed until a resolution of the difference is achieved.

Assessment of Basic Educational Skill Requirements

The Scales of General Educational Development (GED) presented in Section E provide a tool for determining the basic educational skill requirements necessary to perform a job at specified Things, Data, and People functional levels. Basic educational skills refer to reasoning, math, and language skills.

The level of skill the task requires in each of these basic areas is critical information to anyone setting qualification standards. The general education requirement for a job can best be set based on the actual requirements of the tasks assigned to workers in the job. Requirements set in this way have a much firmer foundation that those based on academic credentials. For example, "high school diploma" is a meaningless requirement unless it guarantees possession of certain skills (which it often does not), and only then if those skills are actually the ones needed for successful task performance. Arbitrary diploma and degree requirements are no guarantee to an employer and they may screen out capable, motivated people.

The GED Scales in Section E are ordinal, like the Worker Function and Worker Instructions Scales, and they are used similarly. The analyst

must consider the whole task description, but particularly the worker action and the instructions. He also considers the worker function levels and orientation. Those data should lead him naturally to the appropriate GED levels.

Summary of Steps in Assessing GED Requirements.

1. Scan one scale and identify the level of that skill that seems appropriate (A new analyst should read the scale completely through.)

2. Compare skill level definition with the definitions for the worker function levels of the task.

3. Compare skill level definition with the definition of the instructions level.

4. Does the skill level make sense in relation to others?

5. Does the skill level seem reasonable in relation to the task description wording?

6a. If the answers to 4 and 5 are yes, record the skill level on the task statement form and repeat steps 1-6 for the other two skill areas in turn.

6b. If the answer to 4 or 5 or both is no, evaluate scale levels and/or task description as appropriate, correct, and proceed to assess the other skill areas.

Again, it is helpful for a new analyst to get independent assessments of the GED Scale rating to compare to his own.

Determination of Performance Standards

The next step in completing an FJA task statement is to determine appropriate performance standards. These standards establish the rigor of any qualification testing that may be required. They provide a basis for evaluating the performance of candidates on such tests. The standards also will be important information for the development of training and measures of training outcomes.

Two types of performance standards are defined in FJA: descriptive and numerical. The developers of FJA explain the difference as follows.

Descriptive standards are performance criteria which are generally nonspecific and subjective; e.g., "please type this letter as quickly as possible;" be reasonably accurate in checking these figures;" "don't spend too much time in compiling this report;" "be as complete as possible in collecting the information." They tell in general terms what is expected; but they are wide open to interpretation.

Numerical standards are objective performance criteria which require no interpretation. They usually take the form of numerical or categorical statements; e.g., "please have this letter typed by 5:00 p.m.," "please double-check these figures to ensure that there are no errors." Since they are objective, they explicitly communicate the standards by which performance will be assessed.

In a given work situation, most workers learn through experience (which may be quite frustrating), how to interpret descriptive standards correctly and produce acceptable results. However, descriptive standards are inadequate by themselves for use in setting personnel qualifications. There are some tasks for which it is very difficult to specify numerical or categorical standards. However, if it is not possible or appropriate to be explicit about how the worker's action and the results are to be evaluated, then the task should not affect qualifications. In some cases, it might appear that there are no appropriate numerical or categorical standards at first, but they tend to become evident to the analyst as he writes descriptive standards. In other words writing descriptive standards may be like priming a pump.

Performance standards are determined according to common sense informed by the task description and the worker function scale levels. The worker orientation measure also must be considered. If a task is 80% thing-oriented, then the standard(s) should be set for the worker's functional level in relation to things. In that case, it is not necessary to set a standard for the results of the involvement with, say people, unless that involvement, though relatively minor as a percentage of total involvement, is critical and is not measured by the standard(s) set for things results. Such a situation is unlikely, and if it appears, the analyst should consider whether the task is actually two tasks that ought to be separated.

There is a rule of thumb that may be helpful in writing performance standards:

- If you were a new worker, what information would you need in order to know whether you did the task right?

Using this rule of thumb, and common sense, the analyst usually finds that performance standards flow from the other information in the task statement almost automatically.

Figure D.6. shows performance standards for the example task. Only one descriptive standard is recorded in Figure D.6. Since the example task is highly prescribed, it is easy to identify numerical/categorical standards. The one descriptive standard--"good judgment about when additional testing is needed"--led to an addition to the last categorical standard--"all anomalies of signal response noticed and checked out." This is an example of the pump-priming effect of writing descriptive standards mentioned earlier.

Determination of Training Requirements

This is the final step in completing a task statement and answers the following questions:

Performance standards should evaluate both the worker action (behavior) and the result (output), as exemplified below.

Task: Turn dials, push buttons, observe and sign off in log as to response of light signals on the salinity detection test panel in the engineroom, in order to verify that audio-visual alarms are working, following the 5-step sequential procedure mounted on the test panel console and using own judgment whether to test more than the required sample of test point. Data level, 50%; People Level 1A, 5%; Things Level 1C, 45%.

Performance Standards: Descriptive	Performance Standards: Numerical/Categorical	What is Being Evaluated?	
	Procedure followed exactly in 100% of tests	Action:	Executing all steps in prescribed sequence
	All test actions signed immediately on completion 100% of time	Action:	Keeping log up to date
	100% of required sample of test points checked daily	Action:	Checking all required test points daily
Good judgment about when additional testing is needed	All anomalies of signal response noticed and checked out	Result:	No failure of alarm system goes undetected because of inadequate testing

FIGURE D.6. EXAMPLE OF TASK PERFORMANCE STANDARDS

- What does a worker have to know and be trained to do in order to perform (the task) according to the standards indicated?

- How and where will he acquire this knowledge?

The FJA task statement is designed to provide answers to these questions in all the previous steps following the task description, in its functional and instructional level measures, its basic skill (GED) requirements measures and its performance standards.

Two types of skills are distinguished--functional and specific content skills:

Functional Skills refer to those competencies that enable an individual to relate to Things, Data, and People (orientation) in some combintation according to his personal preferences and to some degree of complexity appropriate to his abilities (level). They include skills like tending or operating machines; comparing, compiling, or analyzing data; and exchanging information with or consulting and supervising people. These skills are normally acquired in educational, training, and avocational pursuits and are reinforced in specific job situations.

Specific Content Skills refer to those competencies that enable an individual to perform a specific job according to the standards required. These skills are normally acquired in an advanced technical training school or institute, or by extensive on-the-job experience. These skills are as numerous as the specific products or services which they produce or the standards and conditions established by employers under which they are exercised.

The reason for the distincition between these two types of skills becomes apparent from their definitions. They are acquired at different times and under different conditions, and too often the appropriate time and place for providing one is confused with the other. The confusion begins from the simple fact that functional skill training in schools must have some specific content. There is however, no reason to assume that the specific content of a specific job situation is accounted for in this type of training.

Sidney A. Fine has delineated the concept of three types of skills in order to comprehend better the nature of human performance. In addition to Functional and Specific Content Skills, he has proposed need for defining and comprehending Adaptive Skills. Adaptive Skills being those which permit a worker to respond correctly to a changing environement. However, since Adaptive Skills do not have a direct relationship to task statements formulated using the FJA technique, they are not dealt with here. It should be noted, however, that Adaptive Skills are regarded as crucial to a worker's job satisfaction and individual growth in a specific job.

Figure D.7. is a chart (from Fine and Bernotavicz, 1973) that provides examples of the three kinds of skills and summarizes some important concepts about them.

Kinds of skills	Examples	Where learned	Appropriate training situation and method
Functional Skills Competencies which enable people to relate to Data, People, and Things. They are expressed in terms of orientation and level.	Tending or operating machines; comparing, compiling, or analyzing data; exchanging information; consulting and supervising people.	School, training institutes, hobbies. Reinforced and developed on the job.	School situation--focus on principles, theories, and range of methods available to achieve desires result. Specific examples used with emphasis on transfer of principles.
Specific Content Skills Competencies which enable people to perform a specific job, using specific equipment, technology, and procedures. They are expressed in the specifics of a task statement.	As numerous as specific products, services, and employers who establish the standards and conditions under which those products and services are produced.	Advanced technical training school or institute, extensive on-the-job experience, or on-the-job training in a specific job.	Specialized schools or institutes. Orientation sessions for on-the-job procedures. On-the-job training either in training shop or through close supervision by supervision by supervisor or assistance from other workers.
Adaptive Skills Competencies which enable people to manage themselves in relation to the demands for conformity and/or change in response to the physical, interpersonal, and organizational conditions of a job.	Management of oneself in relation to authority; to impulse control; to moving towards, away from, or against others; to space (sense of direction and routing); to time (punctuality and self-pacing); to care of property; to dress (style and grooming).	In early childhood experiences, through family and peers; reinforced in school and work situations.	Informal situations, either in school or on the job. Group sensitivity sessions; one-to-one counseling; role-playing; simulation; problem- or crisis-centered techniques. Sensitivity sessions where management and workers come to agreement on accommodations which both can make.

FIGURE D.7. HUMAN PERFORMANCE: A COMPLEX OF THREE INTERRELATED KINDS OF SKILLS

As the chart indicates, the analyst gets functional skills directly from the levels and orientation measures for the task. Specific content skills come directly out of the specifics of the task description.

EDIT OF TASK STATEMENTS

Following completion of the task statements, the editing process begins. The purposes of the edit are:

- To assure that all content elements are included and that their wording in the task description is clear.
- To check whether the task description accurately represents the functional level and orientation, the instructional level and the basic skill requirements of the task.
- To check whether the performance standards and training content appear to be usable operationally (by workers, supervisors, and trainers) and are logically supportable in view of the other parts of the task statement.
- To determine whether the whole task statement gives a sense of reality about the task action and its context.

The edit is done by individual editors. The analysts who initially write the task statement may exchange them for this activity, or other people may perform the edit. The editors must be versed in the use of FJA, and it is helpful if they are knowledgeable about the field of the work system. (When the editor is not familiar with the field, he has to question the writer of the task statement more to clarify a task.)

Summary of Editing Steps

1. Editor reads task description and checks for completeness (all relevant content elements present) and clarity of wording.
2. Editor independently rates worker function level and orientation, worker instructions level, and basic skills (GED) levels, using FJA scales.
3. Editor evaluates performance standards and training content for (a) reasonableness in relation to task description and scale

ratings and (b) practicality (are the standards usable - can worker performance be assessed consistently against those standards; would the training content statements be useful in the development and evaluation of a training program).

The following is a checklist of specific questions to ask when editing task statements:

EDITING CHECKLIST

1. Does the end result of the task make a contribution to the organizational objective?

2. Are the worker action phrase and the result phrase of the task statement in reasonable relation to one another?

3. Does the task description, particularly the worker action phrase, adequately express the context of the task?

4. Does the language in the worker action phrase of the task statement support the worker function levels?

5. Do the worker action and the result phrases of the task statement support the orientation percentages assigned?

6. Is there more than a one-level spread between data, worker instructions, and reasoning scale ratings?

7. Is the result identified in the task a verifiable result?

8. Are the performance standards specified useful to a supervisor and to a worker?

9. Does the training content reflect the knowledge and abilities required to perform the task?

It has been found most useful if a small group of task statements is edited very shortly after the analyst begins writing them, so he can benefit from editing feedback before going on. Subsequent editing is best done on complete sets of task statements for an objective. Then the editor can check the completeness with which the objective is covered.

It is also most helpful if the editor and writer meet personally to discuss the editor's observations about the first set of task statements that is edited. They may reach a level of understanding at which they can communicate adequately in writing or by telephone if that is more convenient.

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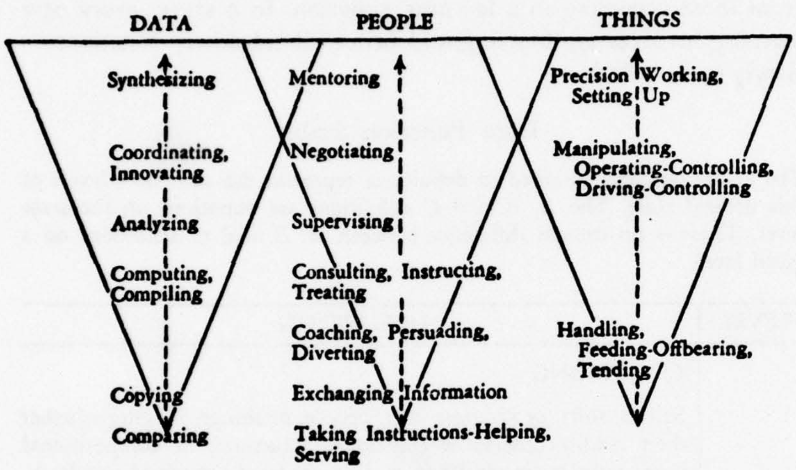
SECTION E: FUNCTIONAL JOB ANALYSIS (FJA) SCALES

Scales for Controlling the Language of Task Statements

Summary Chart of Worker Function Scales



Note: Each successive function reading down usually or typically involves all those that follow it. The functions separated by a comma are separate functions on the same level separately defined. They are on the same level because empirical evidence does not make a hierarchical distinction clear.

The hyphenated functions: *Taking Instructions-Helping, Operating-Controlling, Driving-Controlling,* and *Feeding-Offbearing* are single functions.

Setting Up, Operating-Controlling, Driving-Controlling, Feeding-Offbearing, and *Tending* are special cases involving machines and equipment of *Precision Working, Manipulating,* and *Handling,* respectively, and hence are indented under them.

Complete Version of Worker Function Scales

Data Function Scale

Data should be understood to mean information, ideas, facts, and statistics. Involvement with Data is inherent in the simplest job instruction in the form of recognizing the relationship of a tool to its function or the significance of a pointing instruction. Data are always present in a task even though the major emphasis of the task might be dealing with Things and/or People. Where Things are primarily involved, Data tend to show up as specifications. Where

People are primarily involved, Data tend to show up as information about objective events or conditions, information about feelings, or ideas that could be tinged with objective information and/or feeling. The Data Scale measures the degree to which a worker might be expected to become involved with Data in the tasks he is asked to perform from simple recognition through degrees of arranging, executing, and modifying to reconceptualizing the Data.

It is important to distinguish these functions in a work situation from those occurring in a learning situation. In a sense, every new learning involves synthesizing and hence all subsidiary functions — slowly or in a flash.

Data Function Scale

The arabic numbers assigned to definitions represent the successive levels of this ordinal scale. The *A*, *B*, and *C* definitions are variations on the same level. There is no ordinal difference between *A*, *B*, and *C* definitions on a given level.

LEVEL	DEFINITION
1	COMPARING Selects, sorts, or arranges data, people, or things, judging whether their readily observable functional, structural, or compositional characteristics are similar to or different from prescribed standards.
2	COPYING Transcribes, enters, and/or posts data, following a schema or plan to assemble or make things and using a variety of work aids.
3A	COMPUTING Performs arithmetic operations and makes reports and/or carries out a prescribed action in relation to them.
3B	COMPILING Gathers, collates, or classifies information about data, people, or things, following a schema or system but using discretion in application.

LEVEL	DEFINITION
	ANALYZING
4	Examines and evaluates data (about things, data, or people) with reference to the criteria, standards, and/or requirements of a particular discipline, art, technique, or craft to determine interaction effects (consequences) and to consider alternatives.
	INNOVATING
5A	Modifies, alters, and/or adapts existing designs, procedures, or methods to meet unique specifications, unusual conditions, or specific standards of effectiveness within the overall framework of operating theories, principles, and/or organizational contexts.
	COORDINATING
5B	Decides time, place, and sequence of operations of a process, system, or organization, and/or the need for revision of goals, policies (boundary conditions), or procedures on the basis of analysis of data and of performance review of pertinent objectives and requirements. Includes overseeing and/or executing decisions and/or reporting on events.
	SYNTHESIZING
6	*Takes off in new directions* on the basis of personal intuitions, feelings, and ideas (with or without regard for tradition, experience, and existing parameters) *to conceive new approaches* to or statements of problems and the development of system, operational, or aesthetic "solutions" or "resolutions" of them, typically outside of existing theoretical, stylistic, or organizational context.

People Function Scale

The substance of the live interaction between People (and animals) is communication. In the broadest sense the communication can be verbal or nonverbal. What gives communication its complexity is the heavy load that messages carry; e.g., Data in their objective and subjective forms — the way in which they are delivered (volume, tone, accompanying gesture, and the formal rules and informal customs that govern the context of the communication). Since there is a large subjective element on the part of both the sender and the receiver of a communication, it is very difficult to measure or to assign absolute values or primary importance to one or another type of information in the interaction.

What further complicates pinning down the nature of specific interpersonal behavior is that *affect* can serve as a *tool* for managing oneself in the interaction as well as the informational *substance* of the interaction. Affect, as information and as tool, can occur in the simplest as well as the most complex interactions. For example, affect expressed as a sulky manner, perhaps to gain attention or perhaps to express resentment on the part of an entry worker, can quickly become the informational substance of the interaction, when the supervisor asks nonreactively, "Don't you feel well?" and gets a positive answer, "No, I don't. My child is ill. I should be home!"

The functions in the People Scale deal with these complex questions only indirectly. The assumption of ordinality is somewhat more tenuous than in the Data and Things Scales and depends more heavily on role, status, and authority which are often associated with, but not necessarily a part of, skill. In effect, the functions try to capture the variety of interpersonal behavior *assigned* in various work situations and are more or less arranged, as in the other scales, according to the need, in general, to deal with increasing numbers of variables and with greater degrees of discretion. (The function least likely to fit this pattern is Supervising, which probably could have a scale of its own.)

Skill in dealing with People is undoubtedly as much an art as a methodology, and on every level it is especially necessary to delineate

the descriptive and numerical standards by which a function can be appraised in the task in which it occurs. This is true for the simplest function as well as the most complex. Admittedly, measurement in this area is in a primitive state, but significant beginnings have been made.

In delineating standards for People functions on different levels, one should especially note the cultural boundary conditions and how they moderate the expression of affect on all levels. We have in mind here the rules of courtesy in such a matter as Taking Instructions-Helping, diplomatic protocol in various types of Negotiating, and "rules" of behavior in patient-doctor Mentoring. These cultural boundaries undoubtedly have a very definite effect on the prescription and discretion mix of a particular functional level.

People Function Scale

The arabic numbers assigned to definitions represent the successive levels of this ordinal scale. The *A*, *B*, and *C* definitions are variations on the same level. There is no ordinal difference between *A*, *B*, and *C* definitions on a given level.

LEVEL	DEFINITION
	TAKING INSTRUCTIONS-HELPING
1A	Attends to the work assignment, instructions, or orders of supervisor. No immediate response or verbal exchange is required unless clarification of instruction is needed.
	SERVING
1B	Attends to the needs or requests of people or animals, or to the expressed or implicit wishes of people. Immediate response is involved.
	EXCHANGING INFORMATION
2	Talks to, converses with, and/or signals people to convey or obtain information, or to clarify and work out details of an assignment within the framework of well-established procedures.
	COACHING
3A	Befriends and encourages individuals on a personal, caring basis by approximating a peer or family-type relationship either in a one-to-one or small group situation; gives instruction, advice, and personal assistance concerning activities of daily living, the use of various institutional services, and participation in groups.
	PERSUADING
3B	Influences others in favor of a product, service, or point of view by talks or demonstrations.
	DIVERTING
3C	Amuses to entertain or distract individuals and/or audiences or to lighten a situation.
	CONSULTING
4A	Serves as a source of technical information and gives such information or provides ideas to define, clarify, enlarge upon, or

LEVEL	DEFINITION
	sharpen procedures, capabilities, or product specifications (e.g., informs individuals/families about details of working out objectives such as adoption, school selection, and vocational rehabilitation; assists them in working out plans and guides implementation of plans).
4B	INSTRUCTING Teaches subject matter to others or trains others, including animals, through explanation, demonstration, and test.
4C	TREATING Acts on or interacts with individuals or small groups of people or animals who need help (as in sickness) to carry out specialized therapeutic or adjustment procedures. Systematically observes results of treatment within the framework of total personal behavior because unique individual reactions to prescriptions (chemical, physical, or behavioral) may not fall within the range of prediction. Motivates, supports, and instructs individuals to accept or cooperate with therapeutic adjustment procedures when necessary.
5	SUPERVISING Determines and/or interprets work procedure for a group of workers; assigns specific duties to them (delineating prescribed and discretionary content); maintains harmonious relations among them; evaluates performance (both prescribed and discretionary) and promotes efficiency and other organizational values; makes decisions on procedural and technical levels.
6	NEGOTIATING Bargains and discusses on a formal basis as a representative of one side of a transaction for advantages in resources, rights, privileges, and/or contractual obligations, "giving and taking" within the limits provided by authority or within the framework of the perceived requirements and integrity of a program.
7	MENTORING Works with individuals having problems affecting their life adjustment in order to advise, counsel, and/or guide them according to legal, scientific, clinical, spiritual, and/or other professional principles. Advises clients on implications of analyses or diagnoses made of problems, courses of action open to deal with them, and merits of one strategy over another.

Things Function Scale

Working with Things means literally the physical interaction with tangibles, including taken-for-granted items such as desktop equipment (pencils, paper clips, telephone, handstamps, etc.); blackboards and chalk; and cars. Physical involvement with tangibles such as desktop equipment, etc., may not seem very important in tasks primarily concerned with Data or People, but it is quickly apparent when handicap or ineptness occurs. An involvement with Things can be manifested in requirements for the neatness, arrangement, and/or security of the workplace. Workers who make decisions or take actions concerning the disposition of Things (tools, materials, or machines) are considered to be working mainly with Data, although they physically handle Things (e.g., records, telephone, and catalogs).

Things Function Scale

The arabic numbers assigned to definitions represent the successive levels of this ordinal scale. The *A, B,* and *C* definitions are variations on the same level. There is no ordinal difference between *A, B,* and *C* definitions on a given level.

LEVEL	DEFINITION
	HANDLING
1A	Works (cuts, shapes, assembles, etc.), digs, moves, or carries objects or materials where objects, materials, tools, etc., are one or few in number and are the primary involvement of the worker. Precision requirements are relatively gross. Includes the use of dollies, handtrucks, and the like. (Use this rating for situations involving casual use of tangibles.)
	FEEDING-OFFBEARING
1B	Inserts, throws, dumps, or places materials into, or removes them from, machines or equipment which are automatic or tended ' operated by other workers. Precision requirements are built in, largely out of control of worker.
	TENDING
1C	Starts, stops, and monitors the functioning of machines and equipment set up by other workers where the precision of output depends on keeping one to several controls in adjustment, in response to automatic signals according to specifications. Includes all machine situations where there is no significant setup or change of setup, where cycles are very short, alternatives to nonstandard performance are few, and adjustments are highly prescribed. (Includes electrostatic and wet-copying machines and PBX switchboards.)
	MANIPULATING
2A	Works (cuts, shapes, assembles, etc.), digs, moves, guides, or places objects or materials where objects, tools, controls, etc., are *several* in number. Precision requirements range from gross to fine. Includes waiting on tables and the use of ordinary portable power tools with interchangeable parts and ordinary tools around the home, such as kitchen and garden tools.

LEVEL	DEFINITION
	OPERATING-CONTROLLING
2B	Starts, stops, controls, and adjusts a machine or equipment designed to fabricate and/or process data, people, or things. The worker may be involved in activating the machine, as in typing or turning wood, or the involvement may occur primarily at startup and stop as with a semiautomatic machine. *Operating a machine* involves readying and adjusting the machine and/or material as work progresses. *Controlling equipment* involves monitoring gauges, dials, etc., and turning valves and other devices to control such items as temperature, pressure, flow of liquids, speed of pumps, and reactions of materials. *Includes the operation of typewriters, mimeograph machines, and other office equipment where readying or adjusting the machine requires more than cursory demonstration and checkout.* (This rating is to be used only for operations of one machine or one unit of equipment.)
	DRIVING-CONTROLLING
2C 2D*	Starts, stops, and controls the actions of machines for which a course must be steered or guided in order to fabricate, process, and/or move things or people. Actions regulating controls require continuous attention and readiness of response. (Use this rating if use of vehicle is required in job, even if job is concerned with people or data primarily.)
	PRECISION WORKING
3A	Works, moves, guides, or places objects or materials according to standard practical procedures where the number of objects, materials, tools, etc., embraces an entire craft and accuracy expected is within final finished tolerances established for the craft. (Use this rating where work primarily involves manual or power handtools.)
	SETTING UP
3B	Installs machines or equipment; inserts tools; alters jigs, fixtures, and attachments; and/or repairs machines or equipment to ready and/or restore them to their proper functioning according to job order or blueprint specifications. Involves primary responsibility for accuracy. May involve one or a number of machines for other workers or for worker's own operation.

* 2D OPERATING-CONTROLLING

Starts, stops, controls, adjusts equipment designed to hoise and move materials, reshape and/or pave the earth's surface. Manipulation of controls requires continuous attention and readiness of response to activate the equipment in lateral and vertical operations. (S.A. Fine, 1976.)

Scale of Worker Instructions

LEVEL	DEFINITION
1	Inputs, outputs, tools, equipment, and procedures are all specified. Almost everything the worker needs to know is contained in his assignment. He is supposed to turn out a specified amount of work or a standard number of units per hour or day.
2	Inputs, outputs, tools, and equipment are all specified, but the worker has some leeway in the procedures and methods he can use to get the job done. Almost all the information he needs is in his assignment. His production is measured on a daily or weekly basis.
3	Inputs and outputs are specified, but the worker has considerable freedom as to procedures and timing, including the use of tools and equipment. He has to refer to several standard sources for information (handbooks, catalogs, wall charts). Time to complete a particular product or service is specified, but this varies up to several hours.
4	Output (product or service) is specified in the assignment, which may be in the form of a memorandum or of a schematic (sketch or blueprint). The worker must work out his own ways of getting the job done, including selection of tools and equipment, sequence of operations (tasks), and obtaining important information (handbooks, etc.). He may either carry out work himself or set up standards and procedures for others.
5	Same as (4) above, but in addition the worker is expected to know and employ theory so that he understands the whys and wherefores of the various options that are available for dealing with a problem and can independently select from among them. He may have to do some reading in the professional and/or trade literature in order to gain this understanding.

LEVEL	DEFINITION
6	Various possible outputs are described that can meet stated technical or administrative needs. The worker must investigate the various possible outputs and evaluate them in regard to performance characteristics and input demands. This usually requires his creative use of theory well beyond referring to standard sources. There is no specification of inputs, methods, sequences, sources, or the like.
7	There is some question as to what the need or problem really is or what directions should be pursued in dealing with it. In order to define it, to control and explore the behavior of the variables, and to formulate possible outputs and their performance characteristics, the worker must consult largely unspecified sources of information and devise investigations, surveys, or data analysis studies.
8	Information and/or direction comes to the worker in terms of needs (tactical, organizational, strategic, financial). He must call for staff reports and recommendations concerning methods of dealing with them. He coordinates both organizational and technical data in order to make decisions and determinations regarding courses of action (outputs) for major sections (divisions, groups) of his organization.

Scales of General Educational Development*

Reasoning Development Scale

The Reasoning Development Scale is concerned with knowledge and ability to deal with theory versus practice, abstract versus concrete, and many versus few variables.

LEVEL	DEFINITION
1	• Have the common sense understanding to carry out simple one- or two-step instructions in the context of highly standardized situations. • Recognize unacceptable variations from the standard and take emergency action to reject inputs or stop operations.
2	• Have the common sense understanding to carry out detailed but uninvolved written or oral instructions. • Deal with problems involving a few concrete variables in or from standardized situations.
3	• Have the common sense understanding to carry out instructions furnished in written, oral, or diagrammatic form. • Deal with problems involving several concrete variables in or from standardized situations.
4	• Have knowledge of a system or interrelated procedures, such as bookkeeping, internal combustion engines, electric wiring systems, nursing, farm management, ship sailing, or machining. • Apply principles to solve practical, everyday problems and deal with a variety of concrete variables in situations where only limited standardization exists. • Interpret a variety of instructions furnished in written, oral, diagrammatic, or schedule form.
5	• Have knowledge of a field of study (engineering, literature, history, business administration) having immediate applicability to the affairs of the world. • Define problems, collect data, establish facts, and draw valid conclusions. • Interpret an extensive variety of technical material in books, manuals, texts, etc. • Deal with some abstract but mostly concrete variables.
6	• Have knowledge of a field of study of the highest abstractive order (e.g., mathematics, physics, chemistry, logic, philosophy, art criticism). • Deal with nonverbal symbols in formulas, equations, or graphs. • Understand the most difficult classes of concepts. • Deal with a large number of variables and determine a specific course of action (e.g., research, production) on the basis of need.

*These scales have been modified and adapted by Sidney A. Fine from a table of "General Educational Development" in third edition, *Dictionary of Occupational Titles*, Vol. II (Washington: 1965), p. 652.

Mathematical Development Scale

The Mathematical Development Scale is concerned with knowledge and ability to deal with mathematical problems and operations from counting and simple addition to higher mathematics.

LEVEL	DEFINITION
1	• Counting to simple addition and subtraction; reading, copying, and/or recording of figures.
2	• Use arithmetic to add, subtract, multiply, and divide whole numbers.
3	• Make arithmetic calculations involving fractions, decimals, and percentages.
4	• Perform ordinary arithmetic, algebraic, and geometric procedures in standard practical applications.
5-6	• Have knowledge of advanced mathematical and statistical techniques such as differential and integral calculus, factor analysis, and probability determination. • Work with a wide variety of theoretical mathematical concepts. • Make original applications of mathematical procedures, as in empirical and differential equations.

Language Development Scale

The Language Development Scale is concerned with knowledge and ability to deal with oral or written language materials from simple instructions to complex sources of information and ideas.

LEVEL	DEFINITION
1	• Cannot read or write but can follow simple oral, "pointing-out" instructions. • Sign name and understand ordinary, routine agreements when explained, such as those relevant to leasing a house; employment (hours, wages, etc.); procuring a driver's license. • Read lists, addresses, safety warnings.
2	• Read comic books, "true confession" or "mystery" type magazines (short sentences; simple, concrete vocabulary; words that avoid complex Latin derivations). • Converse with service personnel (waiters, ushers, cashiers). • Copy verbal records precisely without error. • Keep taxi driver's trip record.
3	• Read material on level of the *Reader's Digest* and straight news reporting in popular "mass" newspapers. • Comprehend ordinary newscasting (uninvolved sentences and vocabulary with focus on events rather than on their analysis). • Copy verbal material from one record to another, catching gross errors in grammar. • Fill in report forms, such as Medicare forms, employment applications, and card form for income tax. • Conduct house-to-house surveys to obtain common census-type information or market data, such as preferences for commercial products in everyday use.

• Comprehend orally expressed trade terminology (jargon) of a specific technical nature. (S.A. Fine, 1976)

LEVEL	DEFINITION
4	• Have language ability to take and transcribe dictation, make appointments, and sort, route, and file the mail according to subject. • Write routine business correspondence reflecting standard procedures. • Interview job applicants to determine work best suited for their abilities and experience; contact employers to interest them in services of agency. • Understand technical manuals and verbal instructions, as well as drawings and specifications, associated with practicing a craft. • Guide people on tours through historical or public buildings, tell relevant anecdotes, etc. • *Conduct opinion research surveys involving stratified samples of the population.*
5	• Write instructions for assembly of prefabricated parts into units. • Write instructions and specifications concerning proper use of machinery. • Write copy for advertising. • Report news for the newspapers, radio, or TV. • Prepare and deliver lectures for audiences that seek information about the arts, sciences, and humanities in an informal way. • Report, write, or edit articles for magazines which, while popular, are of a highly literate nature (e.g., *New Yorker, Saturday Review, Scientific American*).
6	• Report, write, or edit articles for technical and scientific journals or journals of advanced literary criticism (e.g., *Journal of Educational Sociology, Science, Physical Review, Daedalus*). • Prepare and draw up deeds, leases, wills, mortgages, and contracts. • Prepare and deliver lectures on politics, economics, education, or science to specialized students and/or professional societies. • Comprehend and apply technical engineering data for designing buildings and bridges. • Comprehend and discuss literary works of a highly symbolic nature, such as works in logic and philosophy (e.g., Kant, Whitehead, Russell).